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ABSTRACT

Two booklets were developed by the Learning in Science Project (Primary)--LISP(P)--to help teachers adopt an approach to primary science teaching which would enhance children's understanding of floating and sinking. Both booklets were designed to enable teachers to reconceptualize their teaching task from activity-driven, didactic teaching to conceptual-change teaching. The first booklet was written for more confident teachers, using a less-structured approach, and the second for teachers who might prefer detailed guidance. Each booklet was evaluated during six 25-45 minute lessons over a 2-week period to determine the extent to which the authors of the booklets were able to convey their intentions to the teachers and to gain an idea of the problems encountered by teachers during the lessons. Data were obtained from student interviews and from a comparison of suggested strategies in the booklets and actual classroom practices. Findings (reported and discussed separately for each booklet) show that actions of the teachers matched the authors' intentions in some respects but departed from them in others and that use of the guide was influenced by the teachers' views of teaching and of how children learn. Implications of these and other findings for teaching science and for developing teaching guides are included. (JN)

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LEARNING IN SCIENCE PROJECT (PRIMARY)

FLOATING AND SINKING:

First teacher trials

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FLOATING AND SINKING : First teacher trials

Ken Appleton[1], Eleanor Hawe, Fred Biddulph,
Elizabeth Hamill[2] and Patricia Gregan[2]

Science Education Research Unit,
University of Waikato,
Hamilton, N.Z.

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1. On leave from Capricornia Institute of Advanced Education
Rockhampton, Queensland, Australia

2. Glenview School, Hamilton

INTRODUCTION

> "What goes into persuading a body of teachers to think about trying new ideas? Can such ideas and curricular practices be communicated using written materials alone? These are hard questions - but they are important ones, if only because written materials represent, when contrasted to in-service courses, workshops, and the like, a potentially most cost-effective way of influencing teachers."
>
> (Westbury, 1983 p.2)

These were the questions in the forefront of the minds of the authors of "Children's questions and science teaching: an alternative approach, with appendix on floating and sinking" (Biddulph and Osborne, 1984) and "Floating and Sinking: some teaching suggestions" (Biddulph, Freyberg and Osborne, 1983). The booklets were written to provide teachers with guidance in adopting an approach to primary science teaching that would enhance their children's ability to make better sense of floating and sinking. According to the authors, they tried to design the booklets in a way that would enable teachers to reconceptualise their teaching task from what Smith and Anderson (1983) call activity-driven, didactic or discovery teaching to conceptual-change teaching. The first booklet was written for more confident teachers who might appreciate a less-structured approach and the second for teachers who might prefer detailed guidance. Both were revised following theoretical analyses by Symington (1983) and other members of the LISP(P) team.

In keeping with the LISP(P) research plan (Biddulph, Osborne and Freyberg, 1983) it was decided to trial the booklets with a range of classroom teachers. This paper reports the first trial of each booklet. Two different teachers undertook the trials.

THE TEACHERS AND SETTINGS

1. Children's questions and science teaching: an alternative approach (BOOKLET 1)

The person who trialled guide booklet 1 was an experienced teacher who had previously seen a member of the LISP(P) team eliciting children's

questions and explanations, so that the idea of working with children's questions was not entirely new to her. Her class consisted of mixed-ability 9-year-olds in an urban school.

The trial comprised four lessons spread over two school weeks.

2. Floating and Sinking: some teaching suggestions (BOOKLET 2)

The person who trialled booklet 2 was a young teacher just entering her second year of teaching. Her class also consisted of mixed-ability 9-year-olds in the same school as the other class. It was the first time she had taught at this level and at the time the trial began she had had her class of children for just two weeks. The teacher was not particularly confident about her teaching at this stage. She was, as she put it, still sorting herself and the kids out. Following the initial lesson she mentioned to an observer several times that she was "only a Year 2 teacher".

The trial itself comprised six afternoon lessons, each of 25-45 minutes, spread over the same two weeks as the other trial.

EVALUATION METHOD USED

The broad purpose of the evaluation was to gain some idea of both the extent to which the authors of the booklets were able to convey their intentions to the teachers and the problems encountered by the teachers in their teaching. Observers who had no perceived commitment to the teaching suggestions were present in the classrooms (one in each) throughout the trials.

Following the methodology of Tasker and Osborne (1983), an attempt was made to compare the suggestions of the booklets with the teachers' intentions for instruction and their actual classroom instruction (Smith and Sendelbach, 1982). Field notes of both informal discussions with the teachers and classroom observations of the lessons were kept for this purpose. Tape recorders were not used during the lessons as it was felt that they would constitute a threat to these teachers (see Barnes, 1983).

Post-trial interviews were also conducted with about ten children from each class, and with the teacher who trialled Booklet 1, approximately one week after the final lessons. All interviews were recorded on audio-tape and later transcribed.

EVALUATION OF TRIAL BOOKLET 1 - Less structured guideline

This booklet proposed a general teaching approach (see Figure 1) based on children investigating their own questions about the topic.

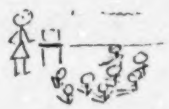
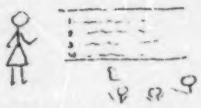
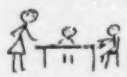
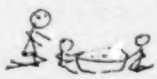
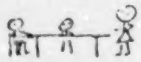
STEP 1 Provide your children with experiences that will enable them to ask questions. Record their questions.	PROVISION OF INITIATING ACTIVITIES 
STEP 2 Decide which questions are to be investigated.	DECISION RE QUESTIONS 
STEP 3 Assist the children to plan their investigations.	GUIDANCE WITH PLANNING 
STEP 4 Provide assistance to the children during their investigations.	ASSISTANCE WITH INVESTIGATIONS 
STEP 5 Assist the children to record, interpret and report their findings.	HELP WITH FINDINGS 

FIGURE 1: Outline of the teaching approach suggested.

For the teacher's own information, an appendix containing details of children's ideas about floating and sinking and suggestions for initiating activities to focus their questions was provided.

In some respects the teacher who trialled Booklet 1 taught in a manner that was consistent with the intentions of the authors but in other respects she did not.

1. Ways in which the teaching was consistent with the suggestions in the booklet

The first two lessons followed reasonably closely steps 1 and 2, and part of step 3, of the suggested teaching approach. During lesson 1 the teacher provided a stimulus and the children generated questions which were written verbatim onto the blackboard by the teacher. The children were then asked to each choose five interesting questions from the list and record them on their own pieces of paper. The teacher also conducted a popularity poll of the questions listed on the blackboard by asking the children to indicate if they found each question, as checked, interesting.

During lesson 2 the children were directed to work in teacher-allocated groups of 5-6 children to select from their personal lists three questions that could form the basis of their group's study. They were asked to select questions interesting to the group and for which they thought they could find answers. Then followed a teacher-led discussion on ways of finding answers to their questions and what 'experimenting' means in practice. The children were then asked to return to their groups, to decide on two ways of finding answers to their questions and to write these on paper.

Thus, in the initial stages of the series of lessons, the approach used by the teacher matched reasonably well the intention of the authors of the booklet.

2. Ways in which the teaching diverged from the intentions of the authors of the booklet

The teacher made a number of significant modications to the approach envisaged by the writers of the booklet. It must be stressed that what

follows is not intended as criticism of the teacher who very kindly agreed to trial the unit. It is more an account of some of the difficulties she encountered when trying to put the suggestions in the booklet into practice.

(a) A different initial stimulus was used.

In the appendix to the booklet the authors suggested several possible initiating activities but the teacher used something of her own to get the children to generate questions about floating and sinking. She showed them two pictures, one of a waterfall and the other of pack-ice, and used these to introduce the topic 'Water and Floating'. The children responded by asking questions about water and ice, rather than about floating and sinking. For example, they asked

"How do we keep the same amount of water?"

"What is water made of?"

"Why in some places is water running and in others it is frozen?"

When this occurred the teacher asked for more questions about floating. A little later, when questions about water and ice were still being asked alongside those about floating and sinking, she introduced a further stimulus - discussing what happens when a person gets in a bath of water - to focus the children on floating and sinking. This additional stimulus was only partially effective in focussing the children's questions in the way the teacher indended. In the end, of 30 questions asked by the children, only nine (see Table 1) related to floating and sinking.

1. Why do people float?
2. Why do logs float when they are heavy?
3. How do ships float in water?
4. Why is it that stones sink and whales don't?
5. How does ice float on water?
6. Why do empty beer bottles float and full ones sink?
7. Why does water in the bath go higher when someone gets in?
8. Why does a ship float [higher] when it's empty and sink [lower] when it's full?
9. Why do some things float in the middle of the water? (i.e. below the surface)

TABLE 1: Children's questions about floating and sinking.

Why did the teacher not use the stimulus suggestions provided in the appendix to the booklet? An informal discussion she had with the observer after the lesson suggested that she hadn't looked carefully at the appendix at that stage. There seemed to be two reasons for this. First, she did not realise that the new approach might initially require more planning time than she normally allocated for science lessons. She had been given the booklet on a Friday and she told the observer she would begin the unit on the following Monday. In retrospect perhaps we should have suggested she take more time before starting. Further, she had had no time that day to find a stimulus other than the two pictures mentioned. In a later interview she reflected on her teaching experience and decided that she would have planned the first lesson differently if she had realised what was involved.

She said,

> "I would have made more of the actual experiences at the very beginning of step 1 and then got the questions from the children because... of course they got onto water, not just sort of floating and sinking. They wanted to know where water came from and what it was made of. Then I just had to cull out the questions and get them to keep to floating and sinking."

A second reason that she hadn't looked carefully at the appendix, it seemed to the observer from informal discussions, was that she did not realise that the information in that section - located as it was in the last part of the booklet - was intended to be used in conjunction with the suggested teaching approach in the first part.

(b) Alternative activities were substituted for later steps of the proposed teaching approach.

Whereas the authors of the booklet intended that the teacher help the children formulate research proposals, guide them during their investigations and assist them record, interpret and report their findings, the teacher who trialled the booklet substituted activities of her own for these steps (i.e. steps 3, 4 and 5), activities which were at variance with the authors' intentions.

For lesson 3, instead of helping children plan investigations to answer their questions, she involved the whole class in an activity to test

which of a range of objects float and which sink. The children tested the various objects provided and then extended the activity themselves by manipulating some of the objects to see if their floating or sinking properties could be changed. For example, plasticine was tried in various shapes, and objects (such as a nail and cork) were linked with string or plasticine. The observer took the opportunity to ask a number of the children how they thought the activities related to their questions. None of the children spoken to, however, saw any connection between their questions and the activity they were involved in. The lesson concluded with a short teacher-led discussion focussing on the children's observations of what had floated and what had sunk, followed by the children being asked to draw a picture and write a sentence about what had happened.

Why did the teacher devote lesson 3 to this activity? There seem to be several reasons why she substituted the 'testing of objects' activity for the other steps in the booklet.

(i) She told the observer that the suggested teaching approach in the booklet did not seem to be leading the children quickly enough to practical activities, something which she felt they enjoyed and which enabled them to find out things. Although she said she realised that the activity was of little help in providing answers to the children's questions, she felt she should provide a more appropriate and interesting stimulus. The view of providing science activities as a means of enjoyment and involvement for the children contrasts with the original view of the authors of the booklet who envisaged activities being devised by the children to try to answer their own questions.

(ii) She was uncertain about how to help the children investigate their questions. During the post-trial interview she alluded to this,

> "Some children come up with some questions that would never cross your own mind and you think: Where do I go from here?"

She told the observer at the beginning of lesson 4 that the booklet did not provide sufficient guidance in this respect. She needed specific suggestions on how to move from children's questions to investigations based on the questions, and she found that an appeal to the observer for guidance on this and other aspects proved unhelpful as the observer was non-committal.

(iii) She was concerned that sufficient and appropriate resources were not available for the children to carry out their own investigations. She referred to this during the interview,

> "They (the children) did come up with some quite good questions (but) there wasn't really anything for them to go and find their answers in."

A little later in the interview she commented,

> "I think the problem everyone's going to have with this (approach) is having enough resources later on for the children to find out because they do usually want to find out."

(iv) She felt it was her responsibility to provide activities for the children, activities which would provide children with valuable helping experiences, even answers. This reason emerged in discussions with the observer and in the interview. During the interview, for example, she said,

> "I would like to be able to provide some experiments .... have some experiments set up that gave them the answer."

The reason she felt she should try to provide activities for the children, she later told one of the authors of the paper, was that she thought the task of devising their own experiments was too difficult for children of this age (9 year olds), unless they had had considerable scientific experience - which her children had not.

(c) Answers were provided to teacher-perceived questions and needs of pupils

The final lesson, lesson 4, also consisted of a substitute for the later steps in the guide booklet. The teacher said during the interview that she was conscious of the fact that the children really did want to find answers to their questions and she mentioned to the observer that she was concerned that she could not tell from the booklet what the children could do to obtain answers to them. She had decided, therefore, to involve them in an activity which she hoped might supply some of the answers they were seeking. She began by having the children recall from the previous lesson which objects floated and which sank. These she listed on the blackboard, putting together contrasting pairs wherever possible; for example, golf ball (which sinks) was listed with table

tennis ball (which floats), and rock with pumice. She pointed out this difference in flotation of objects of similar size. Next the children were formed into groups and each group was given a lump of plasticine which they were asked to experiment with to see if they could get it to float. They were also asked to think of a reason why it floated - if they could get it to float. When the children had spent some time at this (all groups managed to get their plasticine to float) they came back to a whole class group and the teacher asked for their explanations of why the plasticine floated. The two main reasons offered by the children were that it had air in it, or it had something to do with the size and shape. As the teacher explained in the later interview, she thought that the experiment hadn't really provided the children with a satisfactory answer to their questions (just which ones she had in mind was not clear) and that many of the children were keen to have a better explanation. She therefore read from a book an explanation of why some things float and some things sink. This explanation mentioned the relationship between weight of water displaced and weight of the object. When the teacher asked the children if they wanted any further explanation many said they did. She then attempted an explanation in terms of the particulate nature of matter; she told them that some molecules are close together and some are further apart, that when you squeeze the plasticine out the molecules are spread out more and so the plasticine, now having more volume for the same weight, floats. This explanation is not consistent with the scientific view but something about it (perhaps the name 'molecules' or perhaps the fact that it was given by their teacher) must have appealed to the children as eight of the eleven children subsequently interviewed gave this as the explanation for why things float. (Six children also gave 'having air in' and four gave 'because it's light' as reasons why things float.) The lesson concluded with a teacher demonstration and a teacher-led discussion. The children were shown a long candle floating in a container or water and asked to predict at which level a small piece broken from the long candle would float. They were also shown the levels at which a piece of polystyrene and piece of wood floated. Finally they were asked to say what they had learned, their attention having been directed by the teacher via her questions to the size and weight of some of the objects they had seen floating or sunken.

Why did the teacher try to give the children answers to their questions and a scientific-type explanation of why some things float and some things sink? Why did she not try to help them devise investigations to answer their own questions as the booklet suggested? Part of the answer has already been given; she thought the children were not sufficiently skilled to devise their own experiments and she herself was at something of a loss to know how she could help the children devise suitable investigations. Not only was she unable to work it out from the booklet but she had little else to fall back on either. She explained during the interview that she had no personal experience of the approach, "We never did science like this ourselves," and she found she had an inadequate understanding of the topic herself,

> "I thought I knew what it meant but then when the children came up with their questions I couldn't really answer them properly. You know, I couldn't guide them, I felt, to find their own answers."

Since she perceived that the children still wanted answers she seemed to feel under an obligation to try to supply them herself but in trying to do so the teacher found herself in something of a dilemma. On the one hand she didn't really believe that she should be supplying answers because she tended to view learning in science as an inductive or discovery process, that is, a process in which scientific answers - somehow contained inherently within good activities - are found by children without the need for active teaching. On the other hand, when she found that the children did not seem to be able to 'discover' answers to their questions, (six of the eleven children interviewed confirmed that they had not been able to get answers to their questions), and in particular the 'right answer' about why things float or sink, from the activities she did involve them in she began to think that perhaps she should tell them. She described her thinking on this to the interviewer,

> "Really it falls back on the teacher. If the children are desperate you've got to tell them haven't you."

However, when she attempted to do this she realised that she did not know enough about the topic herself to explain it to them. Reflecting on it later, she told the interviewer,

> "I felt that I needed to know more about the actual topic itself... I was floundering round trying to find things out ... I was getting a bit desperate about it and we were talking about it in the staff room and I thought, well, I'll just ask everybody in the staffroom what they think floating and sinking is. Well, I just came out more confused than ever because everybody had a different view."

Thus, for several understandable reasons, the teacher diverged from a number of the proposals in the booklet. Issues which arise from this are considered in a later section.

EVALUATION OF TRIAL OF BOOKLET 2 - Structured guideline

In the introductory section of guide booklet 2 it was stressed that the booklet contained suggestions, nothing more. Teachers were invited to try any that seemed manageable and, if they wished, in an order that seemed appropriate to them. Suggestions included experimental investigations to challenge children's present ideas, experimental projects to extend and apply ideas, and non-experimental projects to relate ideas to practical situations in society.

The actions of the teacher matched the intentions of the authors of this booklet in some respects but departed from them in others.

1. Ways in which the teacher's actions were consistent with the suggestions in the booklet

The teacher who trialled this booklet attempted most of the activities suggested and in the order in which they appeared. She indicated in her initial planning that she intended devoting one lesson to each of investigations 1-4, and this she did. Lesson 5 was spent on experimental investigation 1 because it "looked interesting". She further decided that the suggested non-experimental projects would be a good way to round off the study so she had each child in the class work at these for homework (consulting people and books) and used lesson 6 to review their findings.

The questions which appeared as the headings for each of the proposed activities in the booklet were used by the teacher to introduce and provide the focus for each lesson. She began lesson 5 (experimental

project 1), for example, by saying, "Our question for today is: How can we make non-floating things float?"

The suggestions in the booklet for recording the children's responses were also used by the teacher. In preparation for lesson 1, for instance, she had drawn a blackboard copy of the first suggested recording chart. This chart (see Figure 2) had sections for recording both the children's predictions and their reasons for these. The teacher followed this order and emphasized that the children should make their predictions and give their reasons before they undertook the tests. The approach did not pass unnoticed by the children. During the later interviews three of the nine children commented spontaneously on the way they had made predictions first. One girl, for example, said that she found it very interesting when "we listed the objects down and then we put why we thought they would float or sink, and then we put if they did float or sink."

Recording

(a) Mini-group or individual

Material	We expect it will (float/sink)	Why we think that	We find it (floats/sinks)

Figure 2: Suggested recording chart for investigation 1 in Booklet 2.

Part of the authors' intention with investigation 1 was that the children should find out for themselves which materials - of a range provided - float and which sink. Five of the nine children interviewed referred to these as things they had learned, usually because a particular material behaved in a way that was contrary to their expectations. For instance, when asked to tell about something he had found out that he did not know before, one boy said,

"I thought wood doesn't float but it does."

He further explained, "It seems like it's pretty heavy, but it isn't."

Likewise, two of the nine children interviewed commented that they had learned that holes in floating material, or its length, or the depth of water in which it is floating makes no difference to the level at which it floats, ideas which the authors of the booklet intended the children should gain from the activities suggested.

The idea behind the main activity of experimental project 1 (that it is possible to shape some non-floating materials to float) was one which five of the nine children who were interviewed said they had gained from the lessons. One child, for example, when asked what she had learned that she didn't know before said,

> "I learnt mostly that you can get objects (materials) that sink and make them float, make them into floating objects."

The teacher used the extension activity of experimental project 1 (shaping a non-floater to carry the greatest possible load) and this was apparently a vivid episode for a number of the children too. Four of them commented on it during the interviews. One boy, for example, said,

> "It's good fun, making a little boat out of the spud or else out of the plasticine, see how many marbles we can fit in, see if they float and sink still."

Thus, both the observations and children's comments indicated that the teacher translated a number of the booklet suggestions into practice in a way that was entirely consistent with the authors' intentions.

2. Ways in which the lessons diverged from the intentions of the authors of the booklet

In this section we outline how the teacher either modified or omitted several suggestions made in the guide booklet. We wish to stress that in what follows we are not being critical of the teacher; we are simply reporting differences between what happened and what the authors thought might happen. In fact we have great respect for the teacher in agreeing to undertake the trial at this stage of her career.

(a) The children were offered cues about how to make non-floating materials float.

When the teacher introduced this activity (experimental project 1) she did more than provide the children with non-floating materials (potatoes and plasticine) for them to experiment with; she also provided them with knives and emphasized that care should be taken when they cut or hollowed out the materials. By saying this she gave the children cues as to how she expected the activity to proceed. The cues offered the children by the use of such words, together with the means (knives) to give them effect, were not intended by the authors of the booklet. The teacher may not have meant to give such cues either, as suggested by her remarks to the observer at the end of the lesson, "It's a good type of activity for the children as they are left to work out the problem themselves." In commenting on a draft of this paper, the teacher confirmed that her giving of cues had indeed been unintentional. With reference to the cutting and hollowing out she remarked, "Did I really say that?" However, the guide booklet apparently did not make it sufficiently clear to her that a different type of approach was being advocated.

(b) An experiment was turned into a competition.

The extension activity of the experiment just mentioned was converted into a competition by the teacher, the point of which became for the children: who can get the most marbles into their floating potato or plasticine bowl in the shortest possible time. One of the children who mentioned this activity during the interview commented,

> "We hollowed them (potato and plasticine) out and we had to put marbles in and the group that got the most marbles in without it sinking won the competition, but we didn't get anything for it."

The authors' intention was that the children each be given an equivalent amount of the same material (e.g. plasticine) and allowed to experiment with constructing a floater to carry the greatest possible load. However, the words they actually used in the booklet were:

> "If a number of children are each given an equivalent amount of plasticine they can experiment to see who can construct a floater to carry the greatest possible load."

It is not difficult to imagine that a busy teacher could easily construe this suggestion to mean 'make it a competition', especially if competition provided a useful motivation and control technique -

something which the observer noted and which the teacher later confirmed it did in this case. It is also not difficult to see that under such circumstances the finer details of 'equivalent amounts' and 'same material' could be overlooked.

(c) Groupings of children different in number from those suggested were sometimes used.

The booklet suggests the use of three different sized groups for various activities, namely whole class, individual child, and mini-group, the last being 2-3 children. Of these, it was the mini-group which the teacher modified; she allocated from 4-8 children to a group. For example, during investigation 1 (what things float and what things sink) she detailed children off into groups of 4-6 members, and at the commencement of the 'experiment' (competition) involving the marbles she divided the chilren into four groups of from 6-8 members each. The effect of these larger groupings was that at least half the children in each case were not able to participate actively in the investigations/ experiments and there was a tendency by some of them to not make the most of the learning opportunities provided.

Why then did the teacher organise the children into larger groups? The interviews with, and observation of, the teacher suggested a possible explanation.

Practical constraints of management and equipment influenced her decision. In general the teacher seemed to be in a constant state of compromise between what she would like to do and what she was able to do in the circumstances.

(d) There was little or no attempt to challenge the children's ideas.

The authors of the booklet attempted to produce a guide that would enable teachers first of all to recognise children's ideas and then to challenge and develop the children's ideas towards those which would ultimately be more useful to them. In the present case their intention about recognition seems to have been conveyed satisfactorily - the teacher told the observer that it was useful to find that the ideas of her class were no different from those of other children - but their ideas of challenge and develop were not. The evidence for saying so is as follows:

(i) During group activities the teacher moved about the groups attending to managerial matters but as far as the observer could see she seldom questioned the children about why they thought such and such was the case.

(ii) On those occasions when she assembled the children to record a class summary she tended to fill in the chart with the first statement offered by a child, without questioning others about their views on the matter, and again without questioning the children about why they considered certain things behaved the way they did.

Why was the intention of the authors about challenging and developing the children's ideas - a critical component in their suggested approach - not translated into practice by the teacher? There seem to be several factors that may account for this.

(i) The booklet itself mentions challenging and developing children's ideas but does not emphasise them and does not give specific advice about how they can be done. For a teacher used to teaching in a different way there is little in the booklet to alert him/her to, and guide him/her in the use of, a new and somewhat complex teaching strategy.

(ii) The teacher appeared to plan for the lessons in a manner familiar to many primary teachers, namely in something of a hurry. She told the observer after lesson 1, "I only read the unit last night and was in a rush to get it ready today." It appeared to the observer that the reference in the booklet to challenging children's ideas was overlooked as a result.

(iii) The way the teacher organised the groups and completed the charts suggests that she saw her work as providing activities for and receiving answers from the children but not as challenging or developing their ideas. After looking through a draft of this paper the teacher remarked that she had not helped the children with their ideas as much as she might have because she was forever conscious of having a senior teacher in her room as an observer. That is to say, she experienced an additional element of stress which to some extent inhibited her in her teaching.

(iv) The teacher seemed to be oriented toward a stage theory of intellectual development which in practice meant that she tended not to attempt to influence children's ideas if she suspected the children were not at the 'stage' where they were 'ready' for it. By the end of lesson 1 she had decided that the children's responses during her brief attempt to question them indicated that there was little she could do to move them towards the scientific view - apart from telling them the answer, and she didn't want to do that, she said. She told the observer that the children were very 'hung up' on light and heavy as explanations for why things float or sink; she didn't think they were ready yet to understand such 'abstract notions' as light or heavy for their size (and she may well have been right). In a written evaluation which the teacher made at the end of the series of lessons she expressed this view again. She wrote,

> "The children, however, once hooked onto an instant solution to a question [to why things float] seemed to develop a mental block and could not be questioned further."

When the teacher had read a draft of this paper she confirmed that she had previously thought in terms of stages of development. She added, "We've always been told that if children are not ready to learn, that is, they're not at a stage to understand concepts, they won't".

Thus in offering the children cues, introducing a competition, operating with relatively large groups and not really challenging the children's ideas the teacher diverged from the intentions of the authors of the booklet. Some of the reasons for this appear to stem from a lack of clear advice in the booklet itself. Issues that arise from this, and also from the trial of booklet 1 are now taken up.

ISSUES ARISING FROM THE TRIALS

The two teachers who trialled the guide booklets did not have any special expertise in science and as such were thus representative of a large number of teachers in New Zealand primary schools (Biddulph, 1982). The trials therefore provided a realistic indication of the extent to which the booklets used could alone influence teacher practice. They also provided insights into other issues concerning the development of teacher-guide materials. These indications and issues are now summarised.

(i) Each teacher's interpretation of the guide booklet she was using, and hence her teaching, was influenced by her own view of teaching and how children learn, including the place of activities in that learning. For example, contrary to the approaches advocated in the booklets, neither teacher challenged the children's ideas, one because she saw herself as a manager of group work and believed that the children were not 'ready' to develop their ideas further, and the other because she thought they should 'discover' ideas for themselves or, failing that, that she should give them the scientist's view as she understood it. This teaching response was remarkably similar to that of a 6th grade teacher in the U.S.A. reported by Smith and Sendelbach (1982) and highlights the need for developers of teacher guide materials to identify the beliefs and assumptions that underpin teachers' classroom practices.

(ii) The trials also highlighted the fact that such beliefs and assumptions, and the manner in which these influence the interpretation of guide materials, can only really be identified when observers in classrooms closely observe and describe what happens when the materials are used. In the present case it was clear from the actions of the teachers that they viewed the guide booklets as somewhat similar to published resource units with which they were familiar, rather than as guide materials suggesting a dramatic change in teaching style. For example, from the second teacher's point of view, she thought she had followed the suggestions in Booklet 2 fairly closely but the observer in the classroom was able to identify discrepancies between what was taught (for instance, cuing children to shape plasticine and potatoes into hollow bowl-shaped objects) and what the authors of the booklet intended, discrepancies which escaped the notice of the teacher.

(iii) Arising out of this last issue are the related problems of how to present ideas to maximize their likely acceptance and how to get teachers to actually read and think about them. The limited amount of time taken at first by the two teachers in this study to read the respective guide booklets and plan their lessons suggests that at least initially they saw no need to consider in depth the approach being advocated. This they later confirmed to the third author and added that the teaching approach had turned out to be more involved than they had believed it would be.

Although considerable thought had been given to the presentation of the ideas in the booklets, including the seeking of advice from some teachers, the teachers who undertook the trials nevertheless had difficulties with aspects of the presentation. Developers of guide materials face a dilemma in this regard - too much material and teachers will not either read it or be able to assimilate it (Smith and Anderson, 1983); too little and they will not be able to visualise in practice what the authors intend. In the present case, both teachers said that they found the topic 'Floating and sinking' a difficult one to understand themselves. They considered that the booklet gave them insufficient information in this regard.

(iv) Another issue which arises out of the trials relates to the production of two different guide booklets. We thought that the first teacher may have felt reasonably confident using the less structured booklet but in fact she sought more structure than that provided. It seems therefore that the matter of identifying teachers for whom the less structured version could be suitable would remain problematical. The way around this issue would be to produce just one guide booklet for any specific topic. If it were sufficiently flexible then it would (hopefully) allow any teacher to work from it in the way she or he preferred.

(v) Needs of the classroom, including sustaining children's interest, varying activities and classroom rhythm, being able to help children when and as they need it, and being able to oversee and co-ordinate groups of children must all be met, irrespective of the approach suggested by research theorists (Lampert, 1984). The importance of these factors in the classroom work of the two teachers who undertook the trials, and their difficulties in resolving the conflict between what was proposed and their view of what was practical, cannot be under estimated. Teacher guide materials which do not take these practical issues into account must face distortion in the reality of the classroom. In this regard these trials were a salutory experience for the LISP(P) researchers.

There is a final and more general point: the various constraints evident in the issues outlined, together with the constraints of time experienced by most primary school teachers (who have to plan for a multitude of curriculum subjects), leads us to doubt that guide materials, even if written innovatively in the language of teachers (Olson, 1983), can by themselves promote in teachers the conceptual- change view of teaching necessary to challenge children's ideas. We are inclined to agree with Harlen (1984) and Harris (1983) that written communication needs to be supplemented by interactive communication in the form of special inservice education if the practice of teachers is to be influenced. In the present case, the trialling experience and subsequent discussions with one of the researchers has acted as inservice education for the two teachers involved. They have gone on by themselves to try the general approach with other topics and subjects.

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